

General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.



GENERAL ELECTRIC

HOUSTON, TEXAS

TECHNICAL INFORMATION RELEASE

NASA CR-

160204

TIR 741-MED-3006

FROM R. C. Croston, Ph.D. TO J. A. Rummel, Ph.D.

DATE
1/11/73

WORK ORDER REF:
DM-110T

WORK STATEMENT PARA:
NAS9-12932

REFERENCE:

SUBJECT

User's Instructions for the Cardiovascular Walters Model

(NASA-CR-160204) USER'S INSTRUCTIONS FOR
THE CARDIOVASCULAR WALTERS MODEL (General
Electric Co.) 15 p HC A02/MF A01 CSCL 06B

K79-25721

Unclas
G3/52 22193

This model is a combined, steady-state cardiovascular and thermal model. It was originally developed for interactive use by Dr. R. F. Walters, Department of Human Physiology, School of Medicine, University of California, Davis, California. The model has been converted to batch mode simulation for the Sigma 3 computer. The purpose of the model is to compute steady-state circulatory and thermal variables in response to exercise work loads and environmental factors. During a computer simulation run, several selected variables are printed at each time step. End conditions are also printed at the completion of the run.

R. C. Croston
R. C. Croston, Ph.D.

Attachment
/db



CONCURRENCES

Counterpart:

Medical Projects *C4* Engr'g & Advanced Programs
Unit Manager: CWGFulcher Subsection Mgr. WJBeittel

DISTRIBUTION GE/AGS: Central Product File
R. F. Hassell
V. J. Marks

NASA/JSC:
Tech. Library/JM6 (1979 distribution)

Page No.
1 of 1

PROGRAM DESCRIPTION

A. IDENTIFICATION

Program Name - WALTERS
 Programmer - R. C. Croston, GE/MS, Houston
 Date of Issue - April 6, 1972

B. GENERAL DESCRIPTION

This model is a combined, steady-state cardiovascular and thermal model. It was originally developed for interactive use by Dr. R. F. Walters, Department of Human Physiology, School of Medicine, University of California, Davis, California. The model has been converted to batch mode simulation for the Sigma 3 computer.

C. USAGE AND RESTRICTIONS

Machine and Compiler Required - XDS Sigma 3 and ANSI FORTRAN
 Peripheral Equipment Required - Card reader and line printer.
 Approximate amount of memory required - 2,465 hexadecimal

D. PARTICULAR DESCRIPTION

Equations Used and Derivations - See final report of Contract NAS9-11657, Modification 2C.

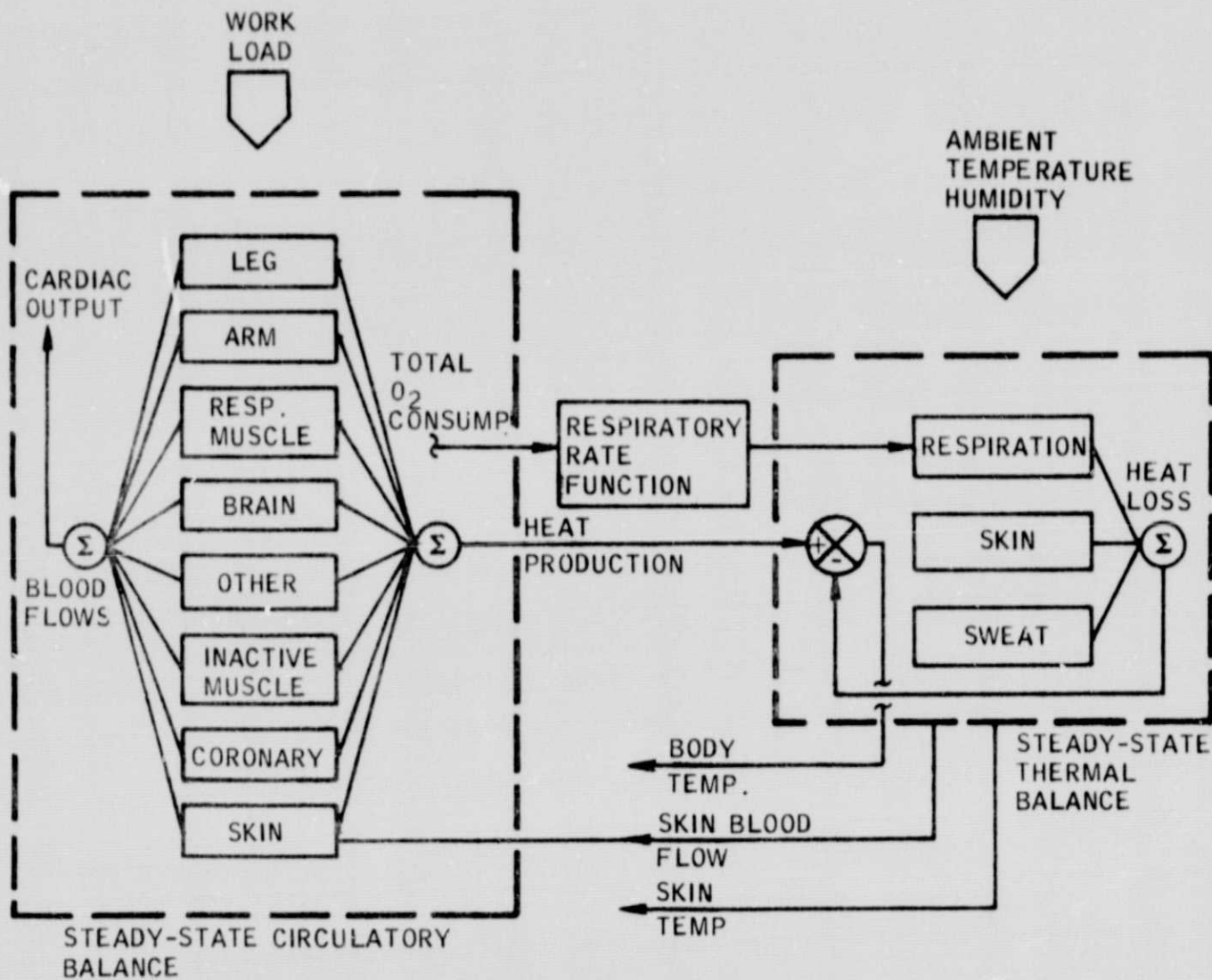
Definition of Terms Used - Terms are defined in the referenced math model and in the following descriptions of input and output variables.

Detailed Description - The mathematical model is summarized here by a functional block diagram, Figure 1. The purpose of the model is to compute steady-state circulatory and thermal variables in response to exercise work loads and environmental factors. During a computer simulation run, several selected variables are printed at each time step. End conditions are also printed at the completion of the run.

E. DESCRIPTION OF INPUT

Control and Program Cards - (begin in card column 1)

```
!JØB
!ASSIGN SI=14      (026 Keypunch Code)
!ASSIGN F:5=3
!ASSIGN F:6=4
!FØRTRAN
```



COMBINED STEADY-STATE CIRCULATORY AND THERMAL MODELS

FIGURE 1.

WALTERS MODEL FUNCTIONAL BLOCK DIAGRAM

(SOURCE DECK)

```
!EØD
!ØLØAD
!$RØØT 256,,GØ
!$MP
!EØD
!XEQ
```

(DATA DECK)

```
!EØD
```

Program Cards - Listed at the end of this document.

Data Cards - (Card columns, format, name definitions)

Columns 1-10, 11-20, etc., 8 parameters per card for a 8F10.0 format of the following list of required input data:

AVCOR	0.138	RESTING A-V DIFF, CORONARY
AVBR	0.069	RESTING A-V DIFF, BRAIN
AVMR	0.067	RESTING A-V DIFF, MUSCLE
AVSKIN	0.010	RESTING A-V DIFF, SKIN
AVOTHR	0.035	RESTING A-V DIFF, "OTHER"
AVRSPR	0.040	RESTING A-V DIFF, RESPIRATORY MUSCLES
AVMMX	0.165	MAXIMUM A-V DIFF, MUSCLE
AVRSMX	0.060	MAXIMUM A-V DIFF, RESPIRATORY MUSCLE
EFARMX	0.80	MAXIMUM EFFICIENCY, ARM MUSCLE
EFLGMX	0.80	MAXIMUM EFFICIENCY, LEG MUSCLE
PCTWLG	0.25	WEIGHT PERCENT, LEG MUSCLE
PCTWAR	0.15	WEIGHT PERCENT, ARM MUSCLE
PCTARS	0.05	WEIGHT PERCENT, RESPIRATORY MUSCLE
PCTWCU	0.015	WEIGHT PERCENT, CORONARY MUSCLE
PCTWIM	0.035	WEIGHT PERCENT, INACTIVE MUSCLE
STOPTM	71.0	STOP TIME FOR LENGTH OF EXPERIMENT (min)
TINC	10.0	TIME AT WHICH VARIABLES ARE INCREMENTED (min) (fixed)

MXRSP	0.315	SLOPE FACTOR FOR INCREASE IN RESP MSCLE O_2
TS	1.0	TIME STEP FOR MODEL (in minutes) (fixed)
VLPIKE	0.04	PERCENT OXYGEN UPTAKE IN VENTILATION
TAIR	20.0	AIR TEMPERATURE ($^{\circ}C$)
RHUM	0.50	RELATIVE HUMIDITY
PATM	760.0	ATMOSPHERIC PRESSURE (mm Hg)
PO ₂	160.0	PARTIAL PRESSURE OXYGEN (mm Hg)
VAIR	0.1524	WIND SPEED (m/sec)
CORST	5000.0	RESTING CARDIAC OUTPUT (ml/min)
WGT	75.0	BODY WEIGHT (Kg)
HGT	175.0	HEIGHT (cm)
TB	36.8	BODY TEMP, INITIAL ($^{\circ}C$)
HRRST	60.0	RESTING HEART RATE (beats/min)
HRMAX	200.0	MAXIMUM HEART RATE
VMAX	20000.0	MAXIMUM VENTILATION (ml/min)
TBMAX	41.0	MAXIMUM BODY TEMPERATURE ($^{\circ}C$)
TPRNT	1.0	PRINT INTERVAL (min)

Col. 1-10, 21-30, 41-50, 61-70 8F10.0 Time to change work rate (sec)

11-20, 31-40, 51-60, 71-80 8F10.0 Work rate in KPM/min

(Seven of the above cards are required for a complete schedule.)

Time (seconds), oxygen uptake (ml/min), ventilation (ml/min), heart
Rate (beats/min), cardiac output (ml/min), body temperature ($^{\circ}C$), and
Skin temperature ($^{\circ}C$).

F. DESCRIPTION OF OUTPUT

The following variables are printed on the line printer. A sample printout is shown in Figure 2.

IJOB EY

IASSIGN F:5=3

IASSIGN F:6=4

IWALTERS

TIME	VB2	V	HR	C ₀	TB	TSKN
0.0	246.6	6166.2	60.0	5000.0	36.8	32.7
1.0	246.6	6166.2	59.3	4945.7	36.7	32.7
2.0	246.6	6166.2	59.3	4945.7	36.7	32.7
3.0	246.6	6166.2	59.3	4945.7	36.6	32.7
4.0	885.6	22141.2	106.6	8886.2	36.6	32.7
5.0	916.1	22902.6	112.8	9398.0	35.6	32.7
6.0	920.1	23002.9	113.6	9465.4	36.6	32.7
7.0	920.6	23016.1	113.7	9474.3	36.5	32.7
8.0	920.7	23017.8	113.7	9475.4	36.5	32.7
9.0	281.7	7043.1	66.4	5535.1	36.5	32.7
10.0	250.8	6271.1	60.2	5016.2	36.4	32.7
11.0	246.8	6169.4	59.4	4947.9	36.4	32.7
12.0	246.6	6166.2	59.3	4945.7	36.3	32.7
13.0	246.6	6166.2	59.3	4945.7	36.3	32.7
14.0	246.6	6166.2	59.3	4945.7	36.2	32.7
15.0	246.6	6166.2	59.3	4945.7	36.1	32.7
16.0	246.6	6166.2	59.3	4945.7	36.1	32.7
17.0	1524.6	38116.1	153.9	12826.7	36.1	32.7
18.0	1586.0	39649.6	166.3	13857.4	36.1	32.7
19.0	1594.1	39851.6	167.9	13993.2	36.1	32.7
20.0	1595.1	39878.2	168.1	14011.1	36.1	32.7
21.0	1595.3	39881.7	168.2	14013.4	36.2	32.7
22.0	317.3	7932.2	73.6	6132.8	36.1	32.7
23.0	255.5	6388.2	61.1	5094.9	36.1	32.7
24.0	247.4	6184.8	59.5	4958.2	36.0	32.7
25.0	246.6	6166.2	59.3	4945.7	35.9	32.7
26.0	246.6	6166.2	59.3	4945.7	35.9	32.7
27.0	246.6	6166.2	59.3	4945.7	35.8	32.7
28.0	246.6	6166.2	59.3	4945.7	35.8	32.7
29.0	246.6	6166.2	59.3	4945.7	35.7	32.7
30.0	246.6	6166.2	59.3	4945.7	35.7	32.7
31.0	246.6	6166.2	59.3	4945.7	35.6	32.7
32.0	2163.6	54091.1	188.7	15722.2	35.7	32.7
33.0	2247.7	56191.9	196.1	16345.4	35.7	32.7
34.0	2252.6	56314.0	196.2	16346.2	35.8	32.7
35.0	2252.6	56314.2	196.2	16346.2	35.8	32.7
36.0	2252.6	56314.2	196.2	16346.2	35.9	32.7
37.0	335.6	8389.3	66.8	5569.7	35.8	32.7
38.0	251.1	6277.8	60.2	5020.8	35.8	32.7
39.0	246.8	6170.3	59.4	4948.5	35.7	32.7
40.0	246.6	6166.2	59.3	4945.7	35.7	32.7
41.0	246.6	6166.2	59.3	4945.7	35.6	32.7
42.0	246.6	6166.2	59.3	4945.7	35.6	32.7
43.0	246.6	6166.2	59.3	4945.7	35.5	32.7
44.0	246.6	6166.2	59.3	4945.7	35.4	32.7
45.0	246.6	6166.2	59.3	4945.7	35.4	32.7
46.0	246.6	6166.2	59.3	4945.7	35.3	32.7
47.0	246.6	6166.2	59.3	4945.7	35.3	32.7
48.0	246.6	6166.2	59.3	4945.7	35.2	32.7
49.0	2483.1	62078.6	189.3	15775.5	35.3	32.7
50.0	2567.6	64189.8	196.8	16398.7	35.4	32.7

51.0	2572.5	64311.9	196.8	16399.5	35.4	32.7
52.0	336.0	8399.7	66.8	5569.7	35.4	32.7
53.0	251.1	6277.9	60.2	5020.8	35.3	32.7
54.0	246.8	6170.3	59.4	4948.5	35.3	32.7
55.0	246.6	6166.2	59.3	4945.7	35.2	32.7
56.0	246.6	6166.2	59.3	4945.7	35.2	32.7
57.0	246.6	6166.2	59.3	4945.7	35.1	32.7
58.0	246.6	6166.2	59.3	4945.7	35.1	32.7
59.0	246.6	6166.2	59.3	4945.7	35.0	32.7
60.0	246.6	6166.2	59.3	4945.7	35.0	32.7
61.0	246.6	6166.2	59.3	4945.7	34.9	32.7
62.0	246.6	6166.2	59.3	4945.7	34.8	32.7
63.0	246.6	6166.2	59.3	4945.7	34.8	32.7
64.0	246.6	6166.2	59.3	4945.7	34.7	32.7
65.0	246.6	6166.2	59.3	4945.7	34.7	32.7
66.0	246.6	6166.2	59.3	4945.7	34.6	32.7
67.0	246.6	6166.2	59.3	4945.7	34.6	32.7
68.0	246.6	6166.2	59.3	4945.7	34.5	32.7
69.0	246.6	6166.2	59.3	4945.7	34.5	32.7
70.0	246.6	6166.2	59.3	4945.7	34.4	32.7

SUMMARY OF CONDITIONS AT TIME OF STOP = 71. MIN

ENVIRONMENT

TAIR = 23.4

HUMIDITY = 0.5 PCT

ATM PRESS = 760.0

AIR SPEED = 0.2

LEG WORK = 33.5ML 82/MIN

ARM WORK = 13.4

* * BODY STATUS

BODY TEMP = 34.354

SKIN TEMP = 32.7

VENTILATION = 6166.2

O₂ UPTAKE = 246.6

CARDIAC OUTPUT = 4945.7

HEART RATE = 59.3

* * OXYGEN DEBITS

CORONARY = 0.4

LEG = 11.5

ARM = 0.0

LEG RATE = 2.386 ML O₂/MIN

ARM RATE = 0.0

G. INTERNAL CHECKS AND EXITS

Exit - A normal exit gives end conditions and a stop.

H. INDEPENDENT SUBROUTINES

None

I. SYSTEM SUBROUTINES

No special subroutines.

J. COMPLETION OR FINAL CHECKOUT DATE

April 6, 1972.

K. PROGRAM LISTING

HUMAN PERFORMANCE MODEL

DEPARTMENT OF HUMAN PHYSIOLOGY

SCHOOL OF MEDICINE

UNIVERSITY OF CALIFORNIA

DAVIS, CALIFORNIA 95616

R. F. WALTERS AND J. C. WILCOX

THIS IS HPMOD II.07 GE VERSION

1/27/72 BY VJMARKS

REAL X(50),Y(50),INCTIM,MXCOR,MAXX,MAXY,MINX,MINY

REAL MLEG,MARM,MRESP,MCOR,MIM,MXRSP

INTEGER A(68),IPR(6),ALFA

LOGICAL FIRST,SWS

REAL CNTL(16),TOTAL(125),PRVAL(50),NAME(125),OUT(45),IN(5),IN(10)

REAL CON(65),OUTNAM(45),PRNAM(50),IGNAME(5),INNAME(10),CONNAM(65)

DIMENSION WK(50)

DATA NCNTL/16,NHATS/125,INOUT/50,IN/13/

DATA CNTL/1TS,1TPRNT,1WLEG,1WARM,1TAIR,1RHUM,1PRESS,1

* 1TINC,1P02,1VAIR,1RESET,1G0,1HELP,1TITLE,1STOP,1WHATS,1

DATA KYES,KNO,KEND,1HY,1HN,3HEND/

DATA OUTNAM/1TIME,1V02,1V,1HR,1CO,1TB,1O2R,1O2IM,1

* 1O20TH,1O2COR,1O2LG,1O2LEG,1O2ARM,1O2SK,1O2RSP,1

* 1O2CO,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2COR,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

* 1O2SK,1O2RSP,1O2LG,1O2ARM,1O2LEG,1O2COR,1O2SK,1O2RSP,1

ABWGT*0.425*HGT*0.725*0.00718
 MLEG*PCT*LG*WGT
 MARM*PCT*ARM*WGT
 MRESP*PCT*HRS*WGT
 MCR*PCT*CB*WGT
 MIM*PCT*IM*WGT
 SV*CRST/HRRST
 02LGMX*MLEG*93.5
 02ARMX*MARM*93.5
 02CMX*HCR*93.5
 02LGMX*MLEG*44/0048
 02ARMX*MARM*44/0048
 02CMX*HCR*44/0048
 02LGMX*MLEG*70/0048
 02ARMX*MARM*70/0048
 02CMX*HCR*70/0048
 BFRR*18*CRST
 BFLEGR*1*CRST
 BFARM*0*CRST
 BFCRR*04*CRST
 BFSKNR*05*CRST
 BFTHR*53*CRST
 023RR*BFRR*AVBR
 CO*CRST
 02LEGR*BFLEGR*AVMR
 02ARM*BFARM*AVMR
 02CRR*BFCCR*AVCR
 02SKNR*BFKNR*AVSKIN
 020THR*BF0THR*AV0THR
 020TR*BF0TR*AV0TR
 020TR*BF0TR*AV0TR
 PCTRSP*1.0 + .01*(760*PRESS)
 IF (PCTRSP.GT.5.) PCTRSP=5.
 02RSPR*PCTRSP/100*02T0TR
 02IMR*16*PCTRSP/100*02T0TR
 02RSPR*02RSPR/AVRSPR
 02IMR*02IMR/AVMR
 02LGMX*02LGMX/16*100.
 02ARMX*02ARMX/16*100.
 02CMX*02CMX/13*100.
 MCCR*02CMX*02CRR)/(HMAX - 0.1*HMAX - HRRST)
 HL6WMX*1.79*VAIR*0.37 + (HVSKN-RHUM*WVAB)*AB*TS*86/60.
 IF (TAIR.GE.21.) TSKIN=32.75
 IF (TAIR.LT.21.) TSKIN=32.75*0.25*(21.-TAIR)
 BFSKNR*BFSKNR*1.-(32.75-TSKIN)*.21)
 400 IF (TSKIN.LT.32.75) GO TO 410
 TBSW*36.9
 GO TO 420
 410 TBSW*(32.75-TSKIN)*.16 + 36.9
 420 02IM*02IMR*TS
 HR*HRRST
 020TH*020THR*TS
 02BR*02BR*TS
 02LEG*02LEGR
 02LG*02LEG*TS
 02ARM*02ARM
 02AR*02ARM*TS
 02CRR*02CRR*TS
 02RSP*02RSPR*TS
 02IM*02IMR*TS
 02SK*02SKNR*TS

```

C      02TOT=02TOTR+TS      116
      WRITE (6,95) 02TOT,02BR,02LG,02AR,02RSP,02COR,02SK,02IM,020TH
      95 FORMAT (' 02TOT,0BR,LEG,ARM,RSP,COR,SKIN,IM,0TH =',/21H ,5F9.3//)
      117
      118
      119
      120
      121
      122
      123
      124
      125
      126
      127
      128
      129
      130
      131
      132
      133
      134
      135
      136
      137
      138
      139
      140
      141
      142
      143
      144
      145
      146
      147
      148
      149
      150
      151
      152
      153
      154
      155
      156
      157
      158
      159
      160
      161
      162
      163
      164
      165
      166
      167
      168
      169
      170
      171
      172
      173
      174
  
```



```

C****
C4000 WRITE (3) PRVAL
C NRECS=NRECS+1
C**** FIRST CHECK TO SEE IF STOP, PRINT, OR OTHER HALT PRINTS REACHED
IF (ISTART.NE.0) GO TO 4001
C WRITE (6,1144) (PRNAM(IPR(I)),I=1,JPR)
1144 FORMAT (1H,3X,6(146,4X))
C WRITE (6,601)
601 FORMAT (' TIME V02 V HR CO TB'
* ' TSKN')
READ (5,10)TPRNT
READ (5,27)WK
27 FORMAT (6(18F10.0),2F10.0)
ISTART=1
4001 IF (TIME.LT.STOPTM) GO TO 4010
C WRITE (6,4002)
C4002 FORMAT (' STOP TIME EXCEEDED. DO YOU WISH PLOT (Y/N)')
C READ (5,900) A(1)
C IF (A(1).EQ.KYES) GO TO 4005
C4003 WRITE (6,4004)
C4004 FORMAT (' DO YOU WISH TO RESTART (Y/N)')
C READ (5,900) A(1)
C IF (A(1).EQ.KYES) GO TO 525
GO TO 10000
C
C4005 REMOVED PLOTTING ROUTINE
C
4010 IF (TIME.LT.PRTTIM) GO TO 4020
PRTTIM=TIME+TPRNT
C ISTART=ISTART+1
C IF (ISTART.LT.10) GO TO 40105
C WRITE (6,1144) (PRNAM(IPR(I)),I=1,JPR)
C ISTART=1
C0105 WRITE (6,4012) (PRVAL(IPR(I)),I=1,JPR)
C CHANGED VARIABLE OUTPUT
40105 WRITE (6,4012) TIME,02TOT,V,HR,CO,TB,TSKIN
4012 FORMAT (1H,3F8.1,6F9.1)
C**** TEMPORARY CONTINUE OPTION
C IPT=0
C CALL TTREAD(A,ALFA,FP,IND,IPT)
C IF (IND.NE.0) GO TO 1006
C**** END OF TEMPORARY SECTION
C
C REMOVED VARIABLE INCREMENTING SECTION
C
4020 T=TIME+60.0
IF (TWK.IISTART) 126,25,25
25 02LEG=WK(IISTART+1)*.485/.23+02LEGR
ISTART=ISTART+2
26 CONTINUE
C**** START EXECUTION LOOP
C**** RESPIRATION RATE
4050 V=02TOT/TS/VUPTKE
C WRITE (6,11) V
11 FORMAT (' V',F10.1)
C**** BRAIN
02BR=02BR+TS
HTBR = 02BR * .004825
C**** INACTIVE MUSCLE

```



```

234 321M = 021MR*TS
235 HTM = 021M * 00+825
236 C*** OTHER COMPARTMENT
237 020TH = 020THR*TS
238 HT0TH = 020TH * 00+825
239 C*** CORONARY COMPARTMENT
240 IF (HR*LT*HRRST) HR*HRRST
241 02COR = (HR*HRRST)*MXCOR + 02C0RR) * TS
242 BFCOR = BFC0RR + (02C0R/TS*02C0RR)/AVCOR
243 HTCOR = 02C0R * 00+825
244 IF (02C0R/TS*LT*02C0MX) GO TO *060
245 DBCO = DBCO + (02C0R/TS*02C0MX)*00+825
246 BFCOR = BFC0MX
247 IF (DBC0*LT*DBC0MX) GO TO *060
248 WRITE (6,*055) DBCO
249 FORMAT (1,02DEBT (CORONARY) EXCEEDS MAX. DEBT = ',F8.1')
250 GO TO 10000
251 C*** LEG MUSCLE COMPARTMENT *
252 4060 02LG = 02LEG * TS
253 RFLEG = RFLEGR + (02LG*02LEGR)/AVMMX
254 IF (RFLEG*LT*BFLEGMX) GO TO *068
255 BFLEG=BFLEGMX
256 DT0BLG = (02LEG*02LG0MX)*00+825
257 IF (DT0BLG*LT*DTLG0MX) GO TO *065
258 WRITE (6,*062) DT0BLG
259 FORMAT (1, RATE OF LEG MUSCLE 02 DEBT ACCUM EXCESSIVE ('F8.3
260 *,'))
261 GO TO 10000
262 4065 DBLEG = DBLEG+DT0BLG*TS
263 IF (DBLEG*LT*DBLG0MX) GO TO *068
264 WRITE (6,*067) DBLEG
265 FORMAT (1, LEG MUSCLE 02 DEBT EXCESSIVE ('F8.1'))
266 GO TO 10000
267 4068 HTLEG = 02LEGR*TS*00+825
268 IF (02LEG*LE*02LEGR) GO TO *075
269 IF (02LEG*GT*(EFLGMX*02LG0MX)) GO TO *070
270 HTLEG = HTLEG + (02LEG*02LEGR)*.75*00+825 * TS
271 GO TO *075
272 4070 HTLEG=HTLEG+((EFLGMX*02LG0MX*02LEGR)*0.75+(02LEG*EFLGMX
273 * 02LG0MX)*0.90)*0.00+825*TS
274 C*** ARM MUSCLE
275 4075 02AR = 02ARM * TS
276 BFARM = BFARMR + (02AR = 02ARMR)/AVMMX
277 IF (BFARM*LT*BFARM0MX) GO TO *082
278 BFARM = BFARMR
279 DT0BAR = (02AR*02ARM0MX)*00+825
280 IF (DT0BAR*LT*DTARM0MX) GO TO *080
281 WRITE (6,*078) DT0BAR
282 FORMAT (1, RATE OF ARM 02 DEBT ACCUM EXCESSIVE ('F8.1'))
283 GO TO 10000
284 4080 DBARM = DBARM + DT0BAR * TS
285 IF (DBARM*LT*DBARM0MX) GO TO *082
286 WRITE (6,*081) DBARM
287 FORMAT (1, ARM MUSCLE 02 DEBT EXCESSIVE ('F8.1'))
288 GO TO 10000
289 4082 HTARM = 02ARMR*00+825*TS
290 IF (02ARM*LE*02ARMR) GO TO *090
291 IF (02ARM*GT*(EFARM0MX*02ARM0MX)) GO TO *085
292 HTARM = HTARM+(02ARM*02ARMR)*.00+825*TS*.75

```

```

4085 HTARM=HTARM*((EFARMX+02ARMX+02ARMR)*0.75+(02ARM+EFARMX
      +02ARMX)*0.90)+0.004285*TS
C*** SKIN OXYGEN CONSUMPTION
4090 O2SK = O2SKR * TS
      HTSKN=02SKR*.004825
C*** RESPIRATORY COMPARTMENT
C*** CALCULATE TOTAL NON-RESP O2 CONSUMPTION
      O2XRSK = (02BR+02COR+02AR+02LG+02SK+02IM+02OTH)
      IF (02XRSK<0.02XPRE) GO TO 4100
      PCRSAD = MXRSP*V/VMAX*4.5
      IF (PCRSAD .LE.0.) PCRSAD = 0.
      PCRSPT = PCRSAD + PCTRSP * 0.01
      O2TOT = 02XRSK / (1.-PCRSPT)
      O2RSP = 02TOT*PCRSPT
      IF (02RSP/TS<LT*02RSPR) 02RSP=02RSPR*TS
      HTRSP = 02RSP*.004825
      BFRSP = BFRSPR+(02RSP/TS-02RSPR)/AVRSPX
      O2APRE=02XRSK
      *100 V = 02TOT/TS/VUPTKE
C*** WRITE (6,10) 02LEG,02ARM,02COR,02RSP,02TOT
      IF (V,LT,VMAX)GO TO 4110
      WRITE (6,102) V
4102 FORMAT (' V EXCEEDS MAXIMUM ALLOWABLE VENTILATION, RATE NOW',F8.1)
      GO TO 10000
C*** SUM TOTAL BLOOD FLOW * *
4110 CB = BFLEG+BFARM+BFSKIN+BFCCR+BFIMR+BFOTHR+BFRSP
C*** WRITE (6,9) CO,BFLEG,BFARM,BFCOR,BFSKIN,BFRSP,BFIMR,BFOTHR,BFRSP
C*** 9 FORMAT (' CO, BFLEG,ARM,COR,SKIN,RESP,IM,OTH,BR =',/, '9F7.1)
C*** 10 FORMAT (' 02(LEG,ARM,COR,RESP,TOT)/', 1,5F10.4)
      HR=CB/SV
      IF (HR<LT*HRMAX) GO TO 4120
      WRITE (6,112) HR
4112 FORMAT (' HEART RATE ',F8.1, ' EXCEEDS MAXIMUM ')
      GO TO 10000
C***
C*** HEAT BALANCE PORTION OF MODEL
4120 CONTINUE
      HTTOT = HTBR + HTLEG+HTARM+HTCOR+HTSKN+HTRSP+HTIO+HTOTH
C*** WRITE (6,14)HTTOT,HTBR,HTLEG,HTARM,HTCOR,HTSKN,HTRSP,HTIM,HTOTH
C*** 14 FORMAT (' HT PRODTTOT,BR,LEG,ARM,COR,SKIN,RSP,IM,OTH,/'
C*** ' 1,5F10.5/ ',4F10.5)
C*** CALCULATE VAPOR PRESSURE AT BODY TEMP
      WVEXP = 10*(8.4051-(2353/(TB+273.18)))*PRESS/101.3
      HLRSK=0.4*V*.85984*(WVEXP-WV)*.2882/((TAIR+273.1)*60.)*TS
      HNET=HTTOT-HLRSK
C*** HEAT LOSS FROM SKIN BLOOD FLOW * *
      HLSKIN = 17.1*AB*(TSKIN-TAIR)*TS*0.85984/60.
C*** WRITE (6,93) TSKIN,BFSKIN
C*** 93 FORMAT (' TSKIN, BFSKIN/ ',2F8.1)
C*** NOTE. OTHER WAYS TO CALCULATE SKIN T. IS THIS BEST ***
      WVSIN = (10*(8.4051-(2353/(TB+273.18)))*PRESS/101.3
C*** CALCULATE HEAT LOSS THROUGH SWEATING * *
      IF (TB<LT*TRSW) GO TO 4150
      IF (TSKIN<LT*29.0) GO TO 4150
      HLSW = 8.4*(TB-TBSW)*TS
      HLSMX=11.79*(VAIR*0.37)*(WVSKN-WV)*AB/60.*0.85984 *TS
      OTSW=TB-TBSW
      IF (OTSW<0.3) OTSW=0.3

```

```

352 BFSKIN=BFSKIN-BFSKIN*(R-DTSM*7./3.
353 IF (HLSW*LE-HLSWMAX) GO TO *158
354 HLSW=HLSWMAX
355 IF (SWSW) GO TO *160
356 WRITE(6,148) TIME
357 *148 FORMAT(' TIME IS',F5.0,' HEAT LOSS BY SWEATING NOW ',
358 * ' AT MAX RATE. ')
359 SWSW=.TRUE.
360 GO TO *160
361 *150 HLSW=0.
362 BFSKIN=BFSKIN
363 DTSM=0
364 IF (.NOT.SWSW) GO TO *160
365 WRITE(6,149) TIME
366 *161 FORMAT(' TIME IS',F5.0,' HEAT LOSS BY SWEATING NOW 0. ')
367 SWSW=.FALSE.
368 GO TO *160
369 *158 IF (.NOT.SWSW) GO TO *160
370 WRITE(6,159) TIME
371 *159 FORMAT(' TIME IS',F5.0,' HEAT LOSS BY SWEATING NOW ',
372 * ' BELOW MAX RATE. ')
373 SWSW=.FALSE.
374 C*** CALCULATE NET HEAT BALANCE, NEW BODY TEMP * *
375 *160 TB = (HTNET-HLSW-HLSKIN)/(WGT*.8)+TR
376 HISTOR = HNET-HLSW-HLSKIN
377 IF (TB-LT-TBMAX) GO TO *170
378 WRITE (6,162) TB
379 *162 FORMAT (' BODY TEMP (NOW ',F8.1,') EXCEEDS MAXIMUM')
380 GO TO 10000
381 C*** SUMMARIZE CHANGES, MOVE TO NEXT TIMESTEP
382 *170 TIME = TIME+TS
383 C*** WRITE (6,15) HLSP,HLSW,HLSKIN
384 C 15 FORMAT (' HT LOSS =',F10.3)
385 GO TO *000
386 C*** SYSTEM HAS FAILED FOR ONE OF SEVERAL REASONS.
387 C*** PRINT OUT FINAL VALUES * *
388 10000 WRITE (6,10002) TIME,TAIR,RHUM,PRESS,VAIR,02LEG,02ARM
389 10002 FORMAT(' SUMMARY OF CONDITIONS AT TIME OF STOP = ',F6.0,' MIN',
390 * ' ENVIRONMENT : / TAIR = ',F8.1,' HUMIDITY = ',F8.1,' PCT' /
391 * ' ATM PRESS = ',F8.1,' AIR SPEED = ',F8.1,' LEG WORK = ',F8.1
392 * ' ML 02/MIN' / ARM WORK = ',F8.1)
393 WRITE (6,10004) TB,TSKIN,V,02TOT,C0,HR
394 10004 FORMAT (/ ' * BODY STATUS' / ' BODY TEMP ',F8.3,' SKIN T',
395 * 'EMP = ',F8.1,' VENTILATION = ',F10.1,' O2 UPTAKE = '
396 * 'F8.1,' CARDIAC OUTPUT = ',F8.1,' HEART RATE = ',F8.1)
397 WRITE (6,10006) DBCG,DBLEG,DBARM,DBTBLG,DBTDBAR
398 10006 FORMAT (/ ' * OXYGEN DEBTS' / ' CORONARY = ',F8.1,'
399 * ' LEG = ',F8.1,' ARM = ',F8.1,' LEG RATE = ',F8.3
400 * ' ML 02/MIN' / ARM RATE = ',F8.1)
401 WRITE(6,1161)
402 READ(5,900) ALL
403 IF (ALL) NE-KYES GO TO 10019
404 WRITE(3) PRVAL
405 NRECS=NRECS+1
406 GO TO *005
407 C REPLACE STATEMENT NUMBERS 10019 AND 10020
408 C0019 WRITE(6,10020)
409 C0020 FORMAT (' DO YOU WISH TO RESTART MODEL (Y/N)')
410 C READ (5,900) ALL

```


C IF (A11).EQ.(YES) GO TO 525

STOP

END

SCALAR MAP

INCTIM	0114(T)	MXCOR	0043(T)	MLEG	0058(T)	MAM	0050(T)	MRESP	005F(T)	MCMR	0061(T)
MIM	0063(T)	MARSP	0032(T)	FIRST	0038(T)	SSW	0039(T)	NCNTL	000A(P)	NHATS	0000(P)
NDUT	000C(P)	MIN	0000(P)	KYES	002E(P)	KVR	002F(P)	KEND	0030(P)	AXPR	0010(T)
AVBR	0012(T)	AVMR	0014(T)	AVSKIN	0010(T)	AVTHP	0018(T)	AVRSPR	001A(T)	AVMX	001C(T)
AVRSMX	001E(T)	EFARMX	0020(T)	EFLGMX	0020(T)	PCWLG	0024(T)	PCWLR	0026(T)	PCWRS	0028(T)
PCWCO	002A(T)	PCWIM	002C(T)	STOPTM	002E(T)	TNC	0030(T)	TS	0034(T)	VUTKE	0036(T)
ISTART	003A(T)	TAIR	003B(T)	RHUM	003D(T)	PRFS	003F(T)	PD2	0041(T)	VAIR	0043(T)
CORST	0045(T)	HGT	0047(T)	HGT	0049(T)	TR	004B(T)	HRRST	004D(T)	HMAX	004F(T)
VMAX	0051(T)	TRMAX	0053(T)	WVABS	0055(T)	WV	0057(T)	AB	0059(T)	SV	0061(T)
DLGMX	0067(T)	D2ARMX	0069(T)	D2COMX	006B(T)	DLGMX	006D(T)	D2ARMX	006F(T)	D2COMX	0071(T)
DTLGMX	0073(T)	DTARMX	0075(T)	DTARR	0077(T)	DTLEGR	0079(T)	DTARR	007B(T)	DTARR	007D(T)
BFSKNR	007F(T)	BFOTHR	0081(T)	D2ARR	0083(T)	CB	0085(T)	D2LEGR	0087(T)	D2ARR	0089(T)
D2CRR	008B(T)	D2SKNR	008D(T)	D2THR	008F(T)	D2T3R	0091(T)	PCTRSP	0093(T)	D2RSPR	0095(T)
D2IMR	0097(T)	BFRSPR	0099(T)	BFRMR	009B(T)	BFLGMX	009D(T)	BFRMR	009F(T)	BFRMR	00A1(T)
DLSTMX	00A5(T)	WVSKN	00A7(T)	TSKIN	00A9(T)	TSW	00AB(T)	D2IM	00AD(T)	HR	00AF(T)
D2OTH	00B1(T)	D2BR	00B3(T)	D2LEG	00B5(T)	D2LG	00B7(T)	D2ARM	00B9(T)	D2AR	00BB(T)
D2CRR	00B9(T)	D2RSP	00BF(T)	D2SK	00C1(T)	D2TOT	00C3(T)	D2CO	00C5(T)	D2LEG	00C7(T)
D2ARM	00C9(T)	DTDBAR	00CB(T)	DTDBLG	00CD(T)	V	00CF(T)	BFSKIN	00D1(T)	BFLG	00D3(T)
BFRMR	00D5(T)	BFRSP	00D7(T)	BFCRR	00D9(T)	WLGINC	00DB(T)	WLGINC	00DD(T)	HUMINC	00DE(T)
TPINC	00E1(T)	PATINC	00E3(T)	P2INC	00E5(T)	VELINC	00E7(T)	HTBR	00E9(T)	HTLEG	00EB(T)
HTARM	00ED(T)	HTSKN	00EF(T)	HTRSP	00F1(T)	PCMSAD	00F3(T)	EXPRE	00F5(T)	EXRSP	00F8(T)
DTSW	00FA(T)	HLSW	00FC(T)	HTTOT	00FE(T)	HTM	0020(T)	HTTOT	0102(T)	HTCRR	0104(T)
WVEXP	0106(T)	HLSW	0108(T)	HTNET	010A(T)	HLSKIN	010C(T)	HISTER	010E(T)	TIME	0110(T)
PRTIM	0112(T)	TPRNT	0116(T)	JPR	0118(T)	I	0119(T)	T	011A(T)	PCRSPT	011D(T)

ARRAY MAP

X	0125(T)	Y	0189(T)	A	01ED(T)	IPR	0231(T)	CNTL	020E(P)	TOTAL	0237(T)
PRVAL	0331(T)	NAME	0395(T)	OUT	048F(T)	IM	04E9(T)	IN	04F3(T)	CON	0507(T)
OUTNAM	0031(P)	PRNAM	0089(T)	IGNAME	008B(P)	IRNAME	0095(P)	CONNAM	00A1(P)	HK	05ED(T)

EXTERNAL PROCEDURES

::AMAX1	::AMIN1	M:RES	L:88S	L:88C	L:33L3	L:33A1	L:33R3	L:33L1
L:33D3	L:33S1	L:3N	L:33E3	L:33D1	L:33A3	L:33M3	L:33E1	L:33M1
L:33S3	L:33T3	L:33T1	L:32R3	L:88S2	L:88C2	L:33S2	L:33L2	L:32E3
L:88W	L:88X							

LABEL MAP

:10	0163	:525	0167	:400	0335	:410	0343	:420	034E	:95	03A1	:102	0490
:103	0498	:600	052C	:900	053F	:4000	0542	:4001	0548	:1144	054B	:601	0561
:27	059F	:4C10	05B4	:10000	0B4A	:4020	05E9	:40105	05C3	:4012	05E1	:26	0612
:25	05FD	:4050	0612	:11	0625	:4060	06C0	:4055	06A7	:4068	0749	:4065	0714
:4062	06F6	:4067	0732	:4075	0791	:4070	0773	:4082	0818	:4080	07E8	:4078	07CD
:4081	08C4	:4090	0863	:4085	0845	:4100	08D8	:4110	0910	:4102	08FF	:4120	095E
:4112	0948	:4150	0A86	:4158	0AC1	:4160	0AF5	:4148	0A64	:4161	0A45	:4159	0A02
:4170	0B42	:4162	0B2A	:10002	0B64	:10004	0BE6	:10006	0C4A				

TEMP ORIGIN OCFB LENGTH 0651

PROGRAM LENGTH 134C

0 ERRORS